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A QUANTITATIVE SYSTEM OF DYNAMIC SKIAMETRY*

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Introduction.

Within the last few years, the determination of refractive conditions by dynamic methods, with the accommodation in use, has developed much more along subjective lines than upon objective. Objective dynamic procedures have been neglectd, not because of the lack of an instrument which could be used for the purpose, but due to the absence of an acceptable technique and a rational method of interpretation of results.

Subjective procedures, even where most careful fogging methods or cycloplegics are used, rarely yield, with any degree of accuracy, an accurate idea of the basic refractive condition. Especially is this true in cases presenting hypertonic ciliary conditions, mechanical cramps, or in individuals who do not respond to the usual subjective or static methods, such as children and adults who are below normal mentally.

Dynamic cross-cylinder tests and other such subjective dynamic methods may be rendered ineffective by unstable lenticular astigmatic compensation, and in any case require, for their success, the complete co-operation of a quite intelligent patient.

Psychological judgment factors in any form of subjective test are always to be considered as presenting valid objections to efforts to develop such methods. It is quite apparent that if a considerable change is made in the retinal image, by a correction of the refractive condition, the new perfect retinal image will be interpreted, due to training and habit, in terms of the old faulty image. Therefore, even when the proper ametropic correction is applied and a perfect retinal image produced, the individual does not have full visual acuity until after the new correction is worn for a considerable period of time. Subjective corrections, therefore, whether obtained by dynamic or static methods, by fogging or cycloplegia, are rarely accurate.

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Objective refraction of any accuracy is limited at the present time to the results obtained by two instruments, the ophthalmometer and the skiascope, and the latter only is useful in obtaining estimates of ametropia and lenticular changes. Procedures looking toward the objective analysis of refractive conditions at the near point, with the accommodation in use, can, therefore, under present conditions be carried on only with a dynamic method of skiametry.

Interest on the part of the writer in problems involved in a development of a usable and quantitative system of dynamic skiametry was aroused in 1921 as the result of the necessity of developing some definite procedure for use in routine clinical work. In an effort to reconcile and relate the very marked variations in dynamic data found in individual cases the writer, the following year, undertook to study the whole problem by statistical methods utilizing the very considerable amount of clinical material which he had available. As the investigation progressed, its field widened due both to the necessity of finding some method of estimating amounts of accommodation used during the dynamic fixation period and of constructing a skiascope to meet the requirements of such methods.

When, after 1901, dynamic skiametry became known due to the pioneer work of Cross[1], many refractionists attempted to use the method suggested by its discoverer and to interpret their findings according to the principles laid down by him. After considerable experimentation general interest in the method subsided because it was found that if the exact correction found by the method was prescribed, no patient could ever have clear distant vision and in other ways gave evidence of overcorrection.

The basic principle of Cross' system of intepretation is that the fixation at near stimulates the full amount of accommodation for the fixation distance. Thus, the basic refractive error would be equal to whatever correction was required to secure neutralization, as Cross believed that the convergent-accommodative relationship would surrender accommodation only to the point of relaxation of the accommodative excess, thereby maintaining the "three to one" ratio.

The judgment of many refractionists that this belief is not justified was upheld in 1917 by Sheard[2] when, as the result of a series of experiments, he demonstrated the presence of a "lag of accommodation behind convergence." The nature of this lag and the reasons for it are still a subject of controversy.

This idea of the flexibility of the accommodative convergent relationship is not new as Donders[3] recognized a certain independence in accommodation and convergence as well as an interdependence.

Sheard[4] further showed that with the method of dynamic and with the modified skiascope developed by him the average lag of

accommodation behind convergence was found to be about .50 D to .75D.

Bestor[5] in a survey of a large number of cases, found the average difference between the dynamic findings and the amount eventually accepted by the patient to be approximately 1.50D. These patients were under 40 years of age and had no evident convergent anomaly or accommodative cramp. Two factors were clearly understood by him; that the difference between his results and Sheard's was due to the technique employed and that the 1.50D difference obtained only in individuals with good accommodative-convergent relationships.

Nott[6] suggests that the lag may be due to the contraction of the pupil at near thus substituting smaller diffusion circles for some accommodation.

Nott[7] also confirmed the findings of Sheard and Bestor as to the average value of the lag and developed a definite method of utilizing its value directly, the "observation behind fixation" method. In this procedure the patient fixes upon a near point card with fixation characters arranged about a central aperture. The observer notes the reflex through the aperture a point behind the fixation so calculated that the difference between the dioptric values of the two distances will be approximately .75D. Nott notes, however, that the technique is of little value in spasm cases or where there is considerable insufficiency of accommodative convergence.

McFadden[8] suggests that the lag may be due to the penetration of the choroid by the incident rays with the result that the secondary light source for emergent rays is actually considerably behind the retinal receptors. With this viewpoint the writer cannot agree as the following data shows a very marked variation of the amount of lag due to age which would not be the case if it were due to purely structural causes.

In addition this factor seems to be present only at near while if it had an anatomical basis it would also be present during static skiametry.

Southall[9] in a mathematical exposition of the subject, considers the lag as the manifestation of certain monochromatic aberrations of the eye, especially apparent during near fixation due to their increased dioptric value at that time.

Atkinson & Woll[10] agree with Southall in the matter but point out that regardless of the reason for its existence, the lag nevertheless must always be considered practically.

Ryer and Hotaling[11] combine an objective dynamic method with a cross-cylinder dynamic subjective procedure and consider that the method includes any lag value which may exist. The writer's experi-

ence with this, is that it requires a very intelligent patient and the findings are difficult of quantitative interpretation.

In a previous paper[12] the writer suggested that the lags of accommodation was simply the manifest portion of the presbyopic curve relative to the point of fixation, and he has since had no good reason to modify his opinion. In any event the amount of the lag at any age corresponds closely with the recession of the accommodative near point beyond the convergent near point when both are related to fixation at one-third meter. All concerned, except Cross, agree that the lag is a very real clinical phenomenon and one which is quite constant in its relative value.

Sheard[13] presenting the matter from a different point of view, that of the practical refractionist, considers the dynamic method as an objective procedure for determining the negative range of relative accommodation. He is supported in this viewpoint by Nott[14]. The writer in the work reported in this paper carries on this conception of negative relative accommodation, and amplifies it. He considers that the lag of accommodation and the negative relative accommodation are manifestations of the same process, viz., the relaxation of the ciliary during accommodation due to the presence of sufficient plus lens power to replace as much accommodation as can be relaxed with a particular fixation convergence.

In the methods thus far presented there has been:

1. An agreement, except for the original work of Cross, that the lag of accommodation behind convergence affected the amount of spherical lens power found at the near point in hyperopia increasing the plus over the static results and decreasing the minus values in myopia.

2. An agreement that this value varies in individual cases, especially those presenting convergence insufficiency thus preventing any constant assurance of the quantitative values of the results.

3. A disagreement as to the actual value of the lag, the estimates ranging from a non-recognition of its existence (Cross) to an average value of 1.50D (Bestor) probably due to non-corresponding or incomplete procedures and failure to take into consideration all near point factors.

4. A disagreement as to the physiological and psychological basis of the lag.

There is therefore, in order to establish a practical system of dynamic skiametry, need for:

(a) A quantitative analysis of the following factors present at the near point, together with a method of computation applicable to the individual case:

1. Lag of accommodation behind convergence.
2. Total negative relative accommodation.
3. Convergent-accommodation.
4. Ciliary tonicity.

(b) A definite objective method developed to ascertain the amount of accommodation retained during the period of the test, so that due allowance can be made for it.

(c) An adequate skiascope developed for use with such a method.

(d) A simple quantitative system of application.

Plan of the Present Study.

Having in mind, as a whole, the problems as set forth, the writer attempted to find a practical solution so that an acceptable dynamic system, capable of being applied clinically, could be developed.

The study was divided into four parts as follows:

Part I. Lag of Accommodation Studies, Development of the Dynamic Fogging Technique, and Recognition of the Neutralization Area.

Part II. Accommodative-convergence and Convergence-accommodation Correlation with Extensions of the Conception of Physiological Exophoria.

Part III. Development of Skiascope Adapted to the Modified Technique.

Part IV. The Present Quantitative System, Its Technique, Interpretation and Application.

Discussion.

When this early part of the study was begun in 1922, there was no idea in the mind of the writer that it would develop into such a long continued systematic investigation, therefore, although some seven hundred cases were tabulated, there was not the close attention to accuracy striven for in the later phases of the work.

With the work of Sheard as a basis and using his plan of fixation on the plane of the skiascope, building up the lens power from zero, and stopping at the point of very rapid with movement, some very interesting data were obtained. During the latter part of this initial investigation, each case, amounting in all to some three hundred, was also subjected to a variation in the above procedure by working out the dynamic finding after the subject had been made considerably myopic for the fixing distance by excess plus lens power. In this portion of the work the difference between the dynamic and

TABLE I.

COMPARATIVE DATA—PART I.

Ten Cases from Among Those Subjected to "Fogging" Dynamic Procedure.

Showing Method of Recording

No.	Age	Dynamic Skiametry		Static Skiametry	Subjective	Apparent Lag. Sheard	Apparent Lag. Fogging
		Sheard	Fogging				
1	39	O. U.+2.50	O. U.+3.25	O. U.+1.25	O. U.+1.25	1.25	2.00
2	21	O. D.+ .75 O. S.— .50	O. D.+1.50 O. S.+ .25	O. D.— .50 O. S.—1.75	O. D.— .75 O. S.—2.00	1.50	2.25
3	33	O. D.+2.00 O. S.+2.50	O. D.+3.25 O. S.+3.75	O. D.+1.00 O. S.+1.50	O. D.+1.00 O. S.+1.50	1.00	2.25
4	20	O. D.+2.00 O. S.+1.75	O. D.+3.00 O. S.+2.75	O. D.+1.50 O. S.+1.25	O. D.+1.50 O. S.+1.25	.50	1.50
5	18	O. U.+2.25	O. U.+3.75	O. U.+1.50	O. U.+1.50	.75	2.25
6	29	O. U.+3.00	O. U.+3.50	O. U.+ .75	O. U.+ .50	2.50	3.00
7	22	O. D.+5.75 O. S.+4.50	O. D.+6.25 O. S.+5.00	O. D.+3.25 O. S.+2.00	O. D.+3.25 O. S.+2.00	2.50	3.00
8	25	O. D.—1.50 O. S.—4.50	O. D.+ .50 O. S.—2.50	O. D.—1.75 O. S.—4.75	O. D.—2.25 O. S.—5.25	.75	2.75
9	30	O. U.+2.25	O. U.+3.75	O. U.+1.25	O. U.+1.25	1.00	2.50
10	6	O. U.+2.00	O. U.+3.00	O. U.+1.50	O. U.+1.50	.50	2.50

NOTE: Spherical values only noted. Cylindrical values, if present, coincided in all four tests, and are eliminated in the interest of simplicity.

static skiametric findings, provided the latter corresponded closely with the subjective, was considered as a lag of accommodation.

Procedure.

During the course of a routine refraction the following findings were noted on the clinic record sheet and afterward copied carefully for statistical anaylsis:

1. Age.
2. Dynamic Skiametry (at ⅓ meter).
   (a) Sheard's method.
   (b) Fogging method (in later cases).
3. Static Skiametry.
4. Subjective.
5. Apparent lag of Accommodation (Difference between 2 and 3). (SEE TABLE No. 1.)

Each case was refracted either by the writer or by one of two assistants, both of whom were carefully trained in the methods employed.

In order that the effect of a considerably diminished accommodative amplitude might be eliminated, no cases of over 40 years of age were included, nor were cases with more than 4Δ of either esophoria or exophoria at distance with the subjective correction. Also excluded were cases with apparent accommodative cramp and those where the cylindrical corrections differed in the various tests.

The skiascopes used in this part of the work were a plain luminous type with a paper clip holding a single fixation chart as suggested by Sheard.

Results.

Table 1 gives the data obtained in ten of the later cases, showing the method of recording, and the statistical analysis of the complete data.

It will be noted that the average value of the lag of accommodation by Sheard's method is somewhat greater than that found by him. This may be explained by the much wider age distribution in this group as later work has shown that the lag value is apparently a function of age. In general, however, and especially among the younger (20 to 25 years) group Sheard's valuations were confirmed.

Some difficulty was encountered in many cases in recognizing the point of neutralization as often additional plus did not result in the expected reversal but caused no apparent change. It was this fact which led to the introduction of the "fogging" technique in an attempt to secure as much accommodative relaxation as possible and a possible fixed point of neutralization. It was found, however, that in most of the cases NO DEFINITE POINT OF NEUTRALIZATION COULD BE FOUND and eventually there came to be an appreciation

of the fact that in any dynamic skiametric procedure there is an area rather than a point of neutralization. The high and low points of this area were finally determined, for practical purposes, as the point of extremely rapid "against" movement when "fogging" down, and the point of extremely rapid "with" movement when building up from zero in the case of a hyperope, and, of course, the opposite in the case of a myope.

It was found that where the lag value by Sheard's method was high, there was usually a smaller neutralization area than where it was low and in a few cases the high and low points coincided where the apparent lag value was a total of 3 diopters. In these latter cases no accommodation was in use at the end of the dynamic procedure and thus the results obtained corresponded to those of a static test at the same distance. In general, the differences between the static results and those obtained by the fogging method were very close to the 1.50D. average difference found by Bestor. It is apparent that Bestor was not satisfied with an apparent neutralization of the shadow movement but continued to add plus power until he obtained a definite reversal of movement, thus continuing through the neutralization area to the high point.

While not included in the data presented herewith, an interesting factor presented itself in the cases where a subjective negative relative accommodation test was made in that the results of the test apparently showed no correlation with the lag of accommodation found by the dynamic procedure. Accurate records were not kept, however, and no quantitative estimates of the differences were made at that time.

Summary.

1. The average lag value for the whole group, 1.12D., was considerably higher than that obtained by Sheard.

2. The lag value for the 20 to 25 year old group, .75D., confirmed rather closely that found by Sheard, and if the few excessively high and total lag cases were eliminated from consideration the value would coincide with his findings.

3. In all except the total lag cases, there was a difference in the results obtained by the "fogging" and the "building-up" dynamic systems, more plus being accepted by the fogging technique. There is, therefore, an area of neutralization having a high and low point instead of a definite single point of reversal.

4. With the fogging technique there was an average difference between dynamic and static results of 1.75D. Eliminating the high lag cases (over 1.50D) found by the Sheard system, the average value of this difference was identical with the 1.50D. found by Bestor[15].

5. No apparent correlation was found between the lag of accommodation and the subjective negative relative accommodation.

Between the time this study was completed and the present, the results obtained in the several thousand cases reported in Parts II and III of this paper have practically confirmed these original findings although the analysis has not been repeated due to the abandonment of the "building-up" method except in presbyopic cases.

TABLE II.

Statistical Data—Part I.

Total Number of Cases	712
Number subjected to "Fogging" Procedure	330
Average value of lag of accommodation (All cases)	1.12D
Average value of lag of accommodation (20 to 25 years)	.75D
Average difference in "Fogging" dynamic and static	1.75D

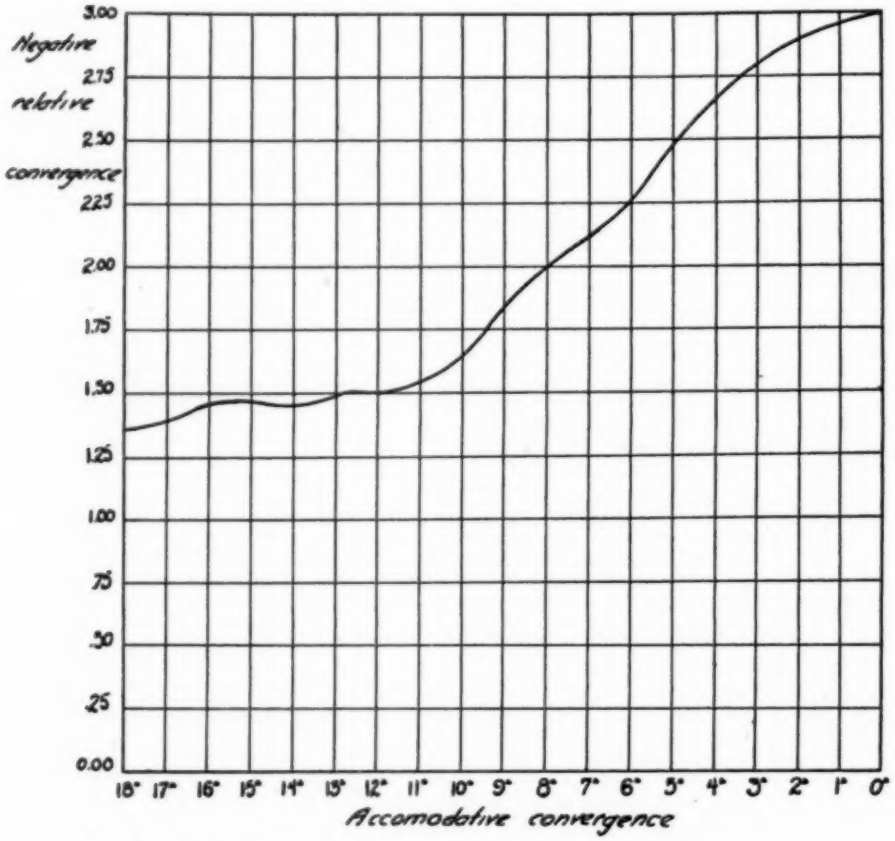
II—Accommodative-convergence and Convergent-accommodation Correlation with Extensions of the Conception of Physiological Exophoria.

In analyzing some of the total and high lag of accommodation cases presented in Part I, the writer was struck with the apparent relationship existing between increased exophoria at near and the increase in lag value. Usually, when there was a considerable amount of exophoria at near, there would be a relatively high lag and, in the latter part of the work, when the one factor was found to be high the other was expected to be, and mostly was, high.

Working on the theory thus suggested, that the accommodation in use during the dynamic test could be estimated by the amount of the accommodative-convergence present under the same conditions, the writer, in 1924, began a systematic investigation of the matter. Nothing in the literature could be found to support this view and apparently no systematic work had even been done so that the investigative methods and their interpretation had to be developed.

As experience with Part I had shown, a nearer approach to the final correction could be obtained in most cases by the "fogging" dynamic system, with its basic deduction of 1.50 D., than with Sheard's method. This method was, therefore, used in all cases.

The measurement of the accommodative-convergence was accomplished at first by plotting the heterophoria values for distance and near, and ascertaining the accommodative-convergence by the graphical method of Sheard[16] but shortly after beginning the work a mathematical formula for this purpose was developed which was universally applicable and which is presented herewith.



Distribution of 1100 cases under age 40.
Accomodative convergence and dynamic static difference relationship at 1/3 meter

FIG. 1

Each case, under 40 years of age, was subjected, during the course of routine refraction, to a careful fogging dynamic procedure at ⅓ meter, together with a careful static skiascopic procedure and the dioptric difference between the two noted. With the static result in place, the distance and near heterophoria was ascertained, the pupillary distance noted, and the amount of physiological exophoria and accommodative-convergence computed. The measurement of the lateral heterophorias was done chiefly by the prismatic dissociation method using a 6Δ prism base-down over the right eye to produce diplopia with a rotary prism over the left for the base-in and base-out prism power. With the latter a vertical co-incidence of the objects was obtained and the amount read off on the rotary prism scale. The usual object for distance was the 20/200 letter of the test chart and the near object was a 3 mm. letter (E) on the usual type of phorometer card set at the ⅓ meter position on the phorometer rod.

The difference between the dynamic and static findings was considered to be negative relative convergence and was graphically compared with the accommodative convergence.

Results.

The results of this comparison in 1,100 cases are shown graphically as a distribution curve in Fig. 1. All types of cases were used except those with a very manifest accommodative cramp or with physiological esophoria.

An analysis of the curve shows practically no decrease in the dynamic-static difference with an increase in accommodative convergence beyond 12. Maddox[17] showed some years ago that 4Δ to 6Δ of exophoria at near, which means a deficiency of accommodative convergence to that extent, was to be expected in the normal case, and Sheard[18] at a later date, verified the observation.

An accommodative convergence of over 12Δ, therefore, does not indicate that more than 1.50D. of convergent or fixation accommodation is in use.

As the accommodative convergence value falls below 12Δ, however, the dioptric difference increases fairly regularly until the limit of three diopters is reached.

Fig. 2 illustrates the distribution of all cases of 12Δ of accommodative convergence with respect to their dynamic-static differences. The exceedingly sharp and high curve found is that characteristic of physiological functions suggesting that we are here dealing with a definite physiological factor.

In the process of tabulating the results, the tedious labor of

calculating graphically the value of the accommodative convergence in each case was simplified considerably by the development of the following formula which is fundamentally accurate and always applicable. As its rationale is quite apparent it will not be discussed at length in this paper. (See following page.)

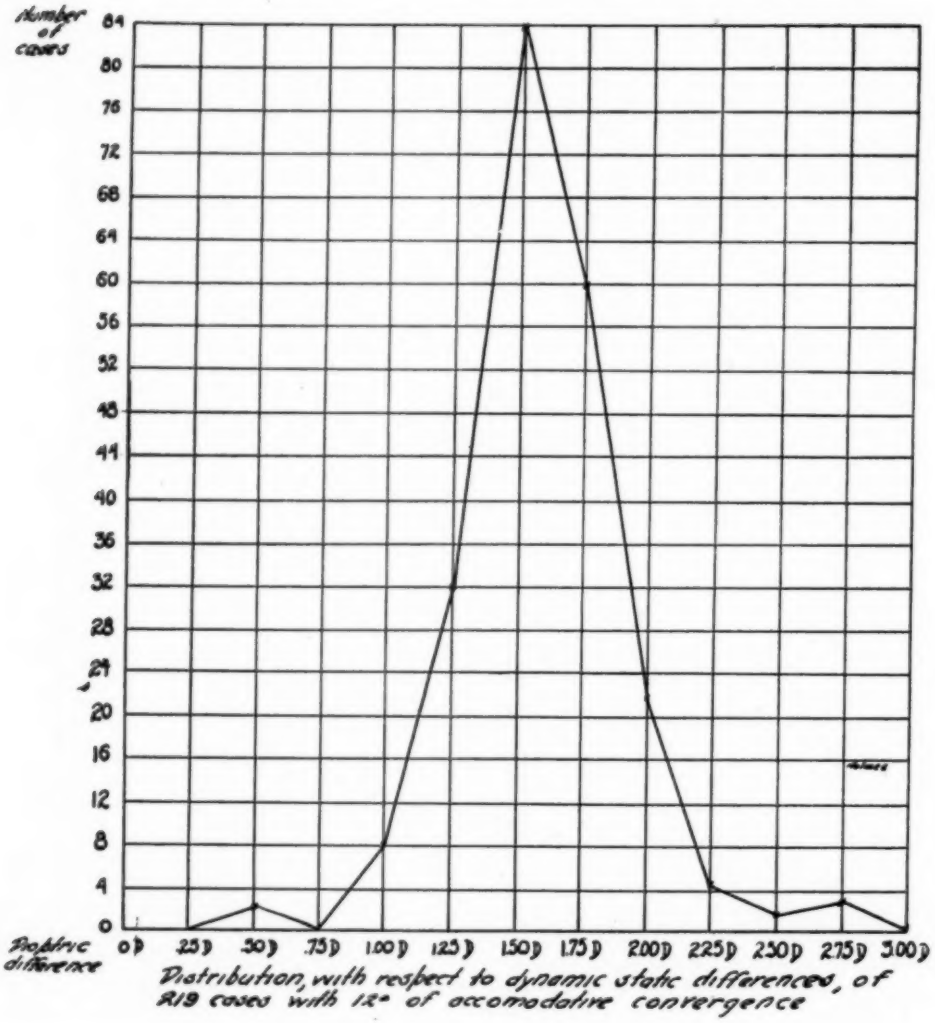


FIG. 2

TC = Total convergence in prism diopters from parallelism to the near point.

E_d = Esophoria or exophoria at distance.
E_n = Esophoria or exophoria at near. (⅓ meter.)
E_p = Physiological exophoria or esophoria.
AC = Accommodative convergence.
Exophoria is considered a minus value and esophoria a plus.

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(1) $E_n - E_d = E_p$.
(2) $TC - E_p = AC$.
Formula: $(1 + 2)\ AC = TC - (E_n - E_d)$.

An analysis of the age groups showed that there were far more cases showing a high accommodative convergence than otherwise without regard to age. Apparently age affects but slightly the accommodative-convergence reflex. Practically every case showed an accommodative relaxation during the dynamic test of at least 1.25 D. Complete relaxation of accommodation was had in very few cases and it was noted that in those cases little accommodative convergence was present. Without question the total relaxation in the other cases was prevented by the accommodation present due to the innervation furnished by the convergent-accommodative reflex. In these cases, the accommodative convergence present was comparatively proportional to the convergent accommodation as shown in Fig. 1.

Summary.

1. There is a close relationship between the amount of accommodative convergence present during a given set of circumstances and the convergent accommodation present at the same time.

The inaccuracy in the interpretation of dynamic skiametric findings lies in the difficulty of determining the amount of accommodation in use during the test. This cannot be measured directly, but apparently it can be estimated indirectly by ascertaining the accommodative convergence which will be relatively proportional. The accommodative convergence and the convergent accommodation seem to be the two sides to the same association reflex.

2. The need for a simple mathematical determination of the amount of accommodative convergence in use during a given fixation and with a given spherical correction, is met by the development of a simple formula as presented above.

III—Development of Skiascope Adapted to the Modified Technique.

During the course of the work reported in Parts I and II, much trouble was experienced in finding a type of instrument which would permit binocular fixation on the part of the patient and yet not have the fixation chart so far from the mirror as to produce an astigmatic aberration. Most of the earlier work in Part II was done either with the Simplex instrument manufactured by the American Optical Company, or with the Ryer Dynamic instrument made by the Shur-On Standard Optical Company. Neither of these were at all satisfactory

PLATE 1
Modified Simplex Skiascope—Front View. (American Optical Company)

for the special technique employed and as greater accuracy became necessary some time had to be given to the development of a suitable skiascope.

The requirements were as follows:

(a) An illumination system giving a small spot at ⅓ meter preferably of the filament source type. The so-called diffused illumination instruments were not usable as they had to be rotated too far to see the movement. With the filament type the slight variations in the central pupillary area could be observed.

PLATE 1a
Modified Simplex Skiascope—Side View. (American Optical Company)

(b) Two fixation charts, one on either side of the instrument, so arranged as to be illuminated at will, and at such a distance as to minimize the possibility of an astigmatic aberration because of the angle between the visual axis and the line of observation. Each fixation chart to be arranged so that it could be seen clearly by the eye under observation as well as the other as for the purposes of the test binocular fixation was necessary.

After considerable experimentation on a student group and a number of clinic patients the two skiascopes discussed above were modified as shown in Plates No. 1, 1a, 2 and 2a, and proved quite acceptable.

PLATE 2
Modified Genothalmic Skiascope—Front View.
(Shur-on Standard Optical Company)

The two charts, one on each side, and on the plane of the skiascope, seemed to be indicated as a considerable number of individuals had trouble in fixing if the charts were placed above or below the mirror. The distance between the center of the charts and the peep hole in the mirror was set finally at 25 mm., which was the most comfortable and efficient distance for the greatest number of the group tested. Some individuals could fix acceptably with a separation distance of 15 mm. but the 25 mm. distance included practically all and at the same time gave a relatively small angle of fixation.

A modified streak instrument was tried but proved a failure due to the demands of the technique for initial fogging for which this type of instrument is unsuited.

PLATE 2a
Modified Genothalmic Skiascope—Side View.
(Shur-on Standard Optical Company)

IV.—The Present Quantitative System, Its Technique, Interpretation and Application.

As a result of the work reported in the foregoing parts of this paper, a definite system for securing and interpreting dynamic skiascopic data in a large number of cases was evolved and put into use with clinical patients in 1926 and has been constantly in use since that time. Some 2,500 cases selected at random from the very considerable number thus refracted have been analyzed carefully.

The present system is as follows:

1. Sufficient plus lens value is placed before the patient to make him quite myopic for the ⅓ meter fixation.

2. With the patient fixing with both eyes on one chart of the modified skiascope at a time, the plus value is gradually reduced until the "high point" of neutralization is reached. If reached in one meridian before the other, minus cylinders are used with their axis in the meridian first corrected. When the patient's right eye is being refracted, the skiascope chart on the patient's left is the fixation chart, and vice versa. The eye not being refracted should be kept slightly myopic for the fixation point.

3. From the dioptric values thus obtained, if the patient is under age 40, an arbitrary subtraction of 1.50 plus diopters is made to secure an initial approximation.

4. With this initial approximate correction in place before the patient, the distance and near (⅓ meter) lateral heterophoria is obtained, the physiological exophoria found, and the accommodative convergence, present under the conditions, calculated.

TABLE III.
Allowances.

Physiologic Exophoria	Accom. Convergence	Allowance ⅓ Meter	Allowance 1/5 Meter
0 — 6	12 — 18	1.50D	2.00
8	10	1.75D	2.50
10	8	2.00D	3.00
12	6	2.25D	3.50
14	4	2.50D	4.00
16	2	2.75D	4.50
18	0	3.00D	5.00

5. The accommodative convergence being proportional to the convergent accommodation in use during the test, is then compared with the values in Table III and Fig. IV, in order to ascertain if the initial approximation is correct. If the accommodative convergence is low, the amount of the deduction from the original results must be increased accordingly as shown by the table, so that a second, and more accurate, approximation can be made.

6. The result obtained by the foregoing procedure will be a very close approximation (usually within 0.25D) of the ultimate correction.

7. In presbyopia the system, for obvious reasons, must be modified as follows:

(a) If the "fogging" system is used the initial deduction, instead of being 1.50 D., is that indicated by the total negative relative value for the age on chart.

(b) For patients over 50 years of age, it is usually better to use Sheard's non-fogging method, beginning with a low plus lens in hyperopia or a high minus in myopia, and stopping at the low point of neutralization. This represents the actual correction at the point of fixation and if the normal addition for the age is subtracted the result will be a quite accurate approximation of the distance refraction. As the usual table of presbyopia additions is calculated for a comfortable near point of about 16 inches. the test should be made at that distance.

In the 2,500 cases cited above, ranged from 10 to 65 years of age, the final comfortable correction was approximated closely by the dynamic analysis in about 85 per cent. Of the others, some presented abnormal heterophoric conditions. others failed to report as to the comfort obtained, and in other cases, where accommodative cramp was present, the patient would not submit to the necessary treatment. On the whole, however, the results indicate the applicability of the system, especially in those cases where relaxation methods have little effect, such as mechanical and convergent ciliary cramps, in partially amblyopic eyes, and in the examination of children or those with subnormal mentality.

Especially is the system valuable in refracting children as subjective methods generally cannot be used and objective methods are apt to be faulty especially where the pupils are abnormally large due to the use of cycloplegics for relaxation.

In order to obtain some idea of the values of the near point factors always present in the normal accommodative-convergent case, an analysis of the total negative relative accommodation was made in 1,745 of the above 2,500 cases which showed an accommodative convergence of 10$^{\Delta}$ or more.

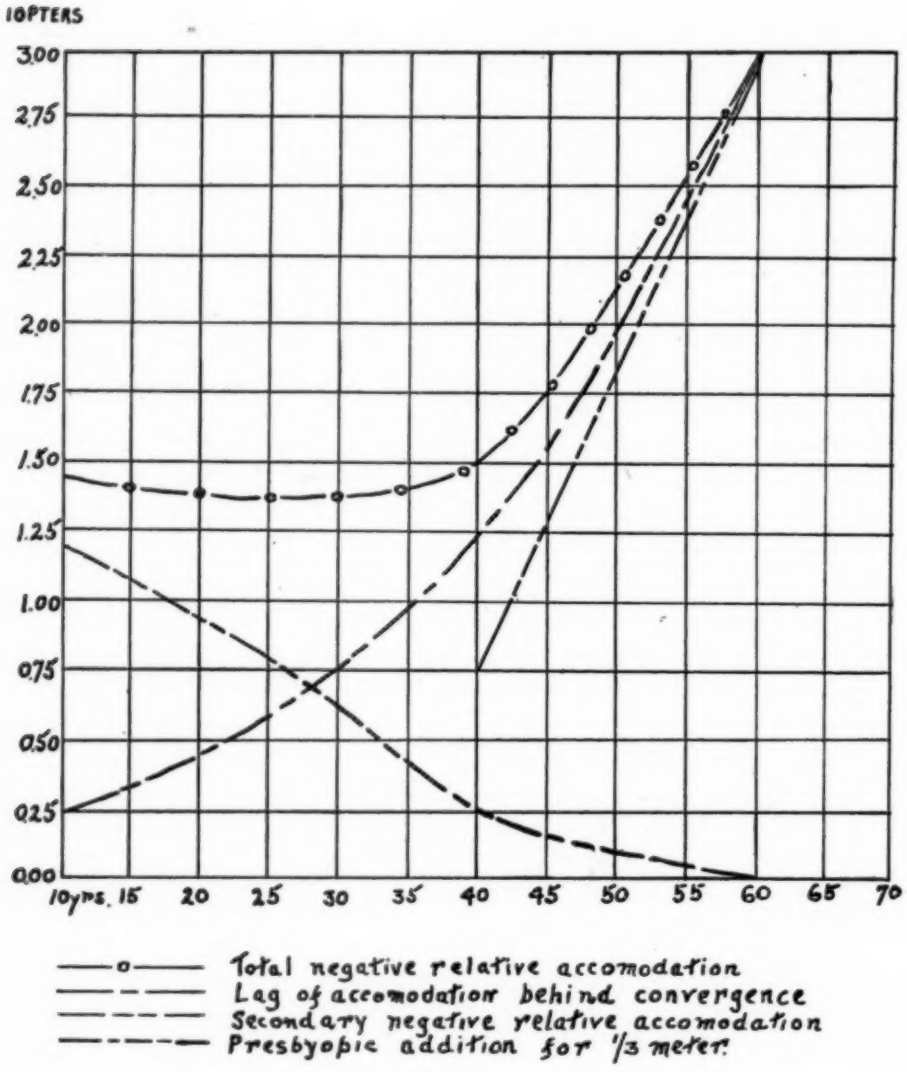

IOPTERS
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
10yrs. 15 20 25 30 35 40 45 50 55 60 65 70
Total negative relative accomodation
Lag of accomodation behind convergence
Secondary negative relative accomodation
Presbyopic addition for 1/3 meter

FIG. 3

Fig. III shows the average values of the total negative relative accommodation according to age, together with the lag of accommodation as shown by Sheard's method. It will be noted that these curves, representing the mean value of the distribution, are quite regular, in fact, too much so for anything but a physiological relationship. Apparently these negative relative values are the result of physiological processes, such as presbyopic development, which are direct functions of age. On the chart will also be found the secondary negative relative accommodation curve which represents the difference between the total negative relative accommodation and the lag of accommodation values. Curiously enough, this latter curve seems to correspond closely with the normal ciliary tonicity values for the given ages. The normal presbyopic addition curve, for ⅓ meter fixation, is included for comparison.

It is apparent that, as accommodative cramp, no matter what its innervational source, is nevertheless accommodation, the accommodation used in near point fixation will include the cramp accommodation if the fixation point is sufficiently close. Thus if the convergent accommodation in play during the dynamic procedure is at its maximum of 1.50 D., an accommodative cramp of a value not to exceed that amount can be included by it and the basis correction found by dynamic interpretation will represent the comfortable correction when the cramp is relaxed. Thus the method affords a ready means of measuring latent hyperopia.

With lesser amounts of convergent accommodation, the amount of cramp which can be included is, as shown in Fig. IV, correspondingly less. Here is shown graphically the fact that as the physiological exophoria and the dioptric allowance increases, the cramp, allowing of indication, decreases.

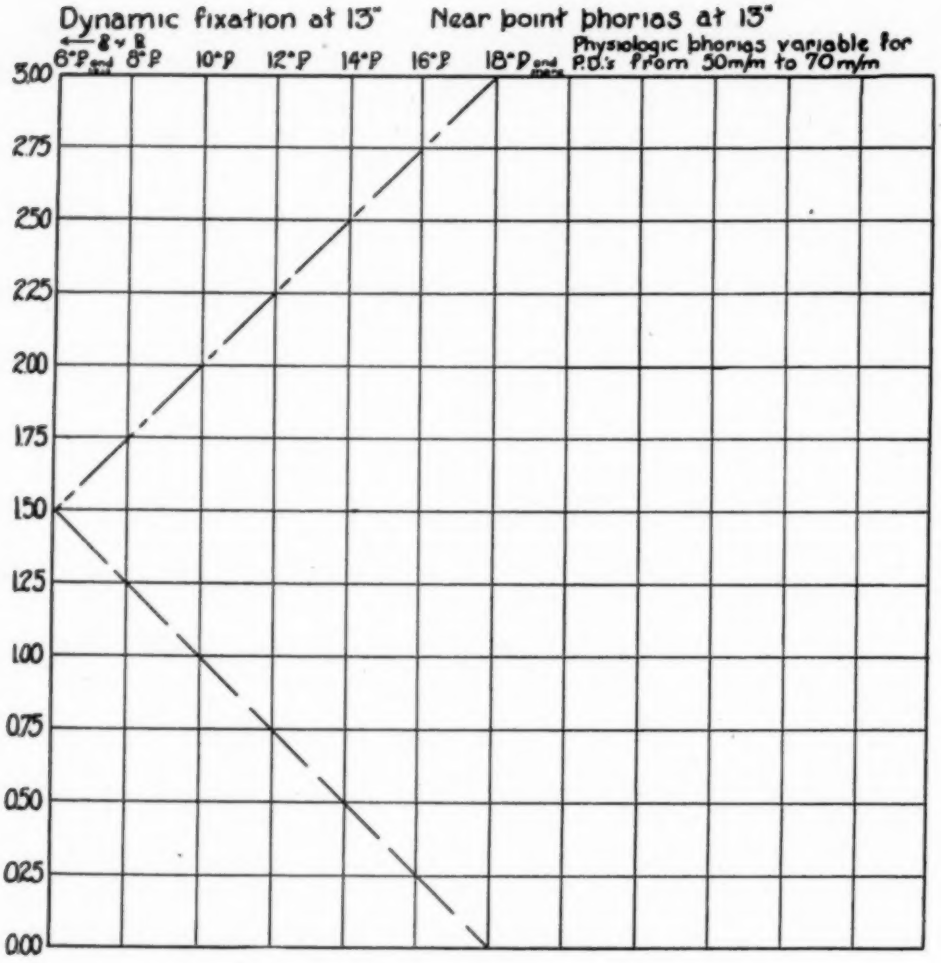
In order to provide for cases with apparently more than 1.50 D. of cramp accommodation a special allowance, as in Table III, was worked out for data obtained at 1/5 meter. This distance, with its maximum convergent accommodation of 2.00 D. will include practically all cramp cases.

Appended herewith are a number of condensed case reports showing the application and interpretation of the system in several types of refractive cases.

Summary and Conclusions.

The results of the studies reported in this paper lead to the following conclusions:

1. That there is a definite negative relative range of accommodation, or lag of accommodation, for any given fixation as found by Sheard.



——·—— total allowance

—— —— total cramp allowing of indication

P physiologic exophoria

8 " orthophoria

P " esophoria

FIG. 4

2. That this negative range has a different value according to the technique used. Its greatest expression in objective work can be obtained by the use of the "fogging" technique.

3. That the negative range of accommodation is prevented from being total for the fixation distance by some positive accommodation stimulated by the convergence for the point of fixation.

4. That this positive relative accommodation or convergence accommodation can be measured by the accommodative convergence found under corresponding conditions. Apparently this is a true association innervation and operative either way.

5. That a quantitative system of dynamic skiametry based upon these conceptions is thoroughly practical in the great majority of cases, and where not immediately applicable leads to a proper analysis of the difficulty.

Condensed Case Reports.

(All data omitted except that pertinent to the dynamic skiametric analysis.)

COMPOUND HYPEROPIC ASTIGMATISM.

1. A. J. Aet 20. Fronto-temporal headaches. Blurred vision after prolonged close work.

Ophthalmometer: O. D. .50 85/175 with rule.
O. S. .50 95/5 with rule.

⅓ m Dynamic O. D. + 3.00 sph. = — .25 cx 175°
O. S. + 2.75 sph. = — .25 cx 5°

Tonicity with initial approximation: Distance 6Δ esophoria.
Near 2Δ esophoria.

Physiological Exophoria 4Δ. Allowance 1.50.

Basic Rx: O. D. + 1.50 sph. = — .25 cx 175° = 20/20 V.A.
O. S. + 1.25 sph. = — .25 cx 5° = 20/20 V.A.

Basic Rx worn with comfort.

PROGRESSIVE MYOPIA.

2. Mrs. C. W. Aet 38. Cannot see for near. Frequent front-temporal and occipital headaches. Wearing O. U. —10.50 sph.

Ophthalmometer: O. D. .25 90/180 with rule.
O. S. .25 90/180 with rule.

⅓ m. Dynamic: O. D. — 7.00 sph.
O. S. — 7.00 sph.

Subjective O. D. — 11.50 sph. = 20/20 —
O. S. — 11.50 sph. = 20/20 —

Tonicity with initial approximation: Distance 1Δ esophoria.
Near 2Δ esophoria.

Physiological Esophoria 3Δ. Allowance 1.50.

Basic Rx: O. D. — 8.50 sph. = 20/200
O. S. — 8.50 sph. = 20/200

Diagnosis: Progressive myopia with ciliary cramp. Over-corrected.

Wearing basic Rx comfortably with 20/30 + V. A. after ten months' treatment with base-in prisms and reduced minus.

MIXED ASTIGMATISM.

Accommodative-convergence Deficiency.

3. J. P. Aet 19. Front temporal headaches with inability to do long continued close work.

Ophthalmometer: O. D. 1.50 95/5 with rule.
O. S. 1.50 80/170 with rule.

⅓ m. Dynamic: O. D. + 3.50 = — 1.00 cx 5°
O. S. + 3.50 = — 1.00 cx 170°

Tonicity with initial approximation: Distance 3Δ Exophoria.
Near 23Δ Exophoria.

Physiological Exophoria 20Δ. Corrected Allowance 3.00.

Basic Rx: O. D. + .50 sph. = — 1.00 cx 5° = 20/20 V.A.
O. S. + .50 sph. = — 1.00 cx 170° = 20/20 V.A.

Exhaustion exophoria. Wearing Basic Rx comfortably after base-in treatment, and has now 4 physiologic exophoria.

COMPOUND MYOPIC ASTIGMATISM.

4. A. B. Aet 25. Distance vision poor. Has some difficulty with close work.

Ophthalmometer: O. D. 1.25 115/25 with rule.
O. D. 1.25 75/165 with rule.

⅓ m. Dynamic: O. D. + .50 sph. = — 1.75 cx 25°
O. S. — 4.75 sph. = — 1.75 cx 165°

Tonicity with initial approximation: Distance 2Δ Exophoria.
Near 14Δ Exophoria.

Physiological Exophoria 12Δ. Corrected Allowance 2.25.

Basic Rx: O. D. — 1.75 sph. = — 1.75 cx 25° = 20/80 V.A.
O. S. — 4.75 sph. = — 1.75 cx 165° = 20/80 V.A.

Exhaustion exophoria. After three months with basic Rx V. A. = O. U. 20/30 —.

Some base-in prism treatment given.

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OPTOMETRY IN ENGLAND*

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To an American traveling abroad, England presents a life more nearly akin to our own than any other European country. Of course the very fact of a common language is bound to make an American feel at home in England. But aside from this there is much in the general life and customs of the English people that closely resembles our own.

The Optometric profession in England occupies a rather unique position in many ways. In some respects our English brethern are far ahead of us in spite of the fact that they are not legally registered as are our American optometrists. In fact, some of their leading men are not at all impressed with the American optometrists' boast of State recognition and legal registration. They claim, and with a good show of reason, that legal registration is not an unmixed blessing. To be sure it forces high educational standards upon newcomers to the profession, but as our English friends say, where these standards are voluntarily sought after, are not the men who of their own volition strive after high educational qualifications superior to the men who do so only under compulsion. Then again, registration while bestowing rights also sets up limitations and the latter may more than offset the former. I mention this attitude on the part of some prominent British optometrists as an interesting phase of the "other side" of registration. Such an attitude was certainly new to me and will be news to our American optometrists. But of course the vast majority of men realize that the benefits of registration outweigh its shortcomings and are striving for parliamentary recognition.

Probably the most interesting phase of optometry in England and one of the two or three things in which England is many steps ahead of us is the founding of the Refraction Hospital. The London Refraction Hospital is the first of its kind in the world. A placque on the outside of the hospital building recording the opening of the new building under the patronage of the Countess of Mayo proudly states this fact. Of course now there have been several other refraction hospitals in other cities in England opened, with the prospect of more in the near future. This in itself is an attestation to the success of the institution.

The term, Refraction Hospital, it must be said, at first sounded anomalous to me and will unquestionably sound likewise to our American optometrists. For a hospital is primarily associated with disease and we have been taught to regard errors of refraction as

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distinctly not disease. Yet it is amazing how rapidly one gets over the first impression and readily becomes accustomed to the idea and phrase of the Refraction Hospital.

The history of this hospital is the story of a bitter struggle by British Optometrical leaders to have a place of their own where students might have a chance to gain first class practical experience and knowledge of the pathology of the eye. The work of the hospital has since expanded greatly, but the original idea had been for a hospital used largely as a training place for the recognition of disease and the study of drugs in connection with refraction.

The importance of pathology to the optometrist is one that has long agitated the British optometrists and it cannot be denied that there is no unanimity amongst the British men regarding the place of pathology in optometric training. The stressing of pathology that was one of the causes for the opening of the Refraction Hospital is not shared by all men in England.

However, whether one is in sympathy with the view of the men behind the hospital that pathology is one of the most important elements in the training of optometrists or not, one cannot help admiring the fortitude of the leaders who made this urge and desire for a hospital of their own a reality. Furthermore, the establishment of the hospital and its successful operation has given the British optometrist a standing in the community which would have been otherwise unattainable. The hospital stands perhaps in a similar relationship to British optometry that the university courses do in America. They are always pointed to with pride as evidence of the profession status of optometry.

Relation Between Optometrists and Oculists in England

There has been for years and still continues a feeling of hostility between optometrists and a great many of the oculists in England. This feeling is not strange to us on this side of the water. But the British optometrists have been far more fortunate in that a number of leading oculists have taken up a very sympathetic attitude towards optometrists and aided them in every way possible. A few of these leading ophthalmic surgeons, also well known in our country, include Dr. Lindsay Johnson and the late Dr. Wm. Ettles. But there are a number of others who have helped the optometrist very greatly in his work for advancement. The founders of the Refraction Hospital repeatedly say that to some of these ophthalmic surgeons a great deal of credit is due for the moral support which encouraged the optometrists and the Institute of Ophthalmic Opticians to work on this great enterprise.

Even before the establishing of the hospital and as a prelude to it, these sympathetic medical men conducted classes for the optometrists for the purpose of educating them in the signs and symptoms of ocular pathology. Amongst these pioneers may again be mentioned the late Dr. Ettles, one of their leading ophthalmic surgeons,

and Dr. Lindsay Johnson.

The question of a hospital, which had long been considered, was very strongly opposed by many people. It was said that they would never find a place for a hospital, and if they found a place they would not get any students and even if they got students they would never get a staff. And finally, if they got the place, the students and the staff they would never get any patients. But despite such discouragement and opposition through the direct incentive given by a leading ophthalmic surgeon, who is a very good friend of the optometrists though his name is rarely openly associated with optometry, the hospital actually became a reality in January, 1923.

In January, 1923, the first Refraction Hospital was opened in London in an old building on Newington Causeway, which strangely had been everything from a Veterinary Surgeons' Equine Hospital to a gambling hall. Although in a very dilapidated condition it was renovated into a hospital, and it was the Institute of Ophthalmic Opticians which gave practically all the money that made this building possible. The equipment was almost entirely provided by the wholesalers gratis.

The number of patients at the end of the first year was 748. That has steadily grown year after year until for the last twelve months the number was well over 7,000. I understand that for the month of March, 1929, the number of patients was about 800, more than all the patients during the entire first year. This matter of attracting patients was a very great difficulty and during the first months it seemed as though the people who had said they would "never get any patients" were to have their opportunity for a hearty laugh. One can readily understand why such a novel institution as a refration hospital would not meet with immediate favorable response. The idea of a refraction hospital was certainly new to the patients who had been visiting hospitals of all kinds before. But the need for such a refraction hospital soon evidenced itself by the fact that as soon as, so to say, "the ice was broken," and the people learned what the hospital was for, the number of patients increased by leaps and bounds, so much so that even the new and large hospital is utterly inadequate to take care of all those desiring admission. The problem of securing a staff was never a great problem. Perhaps the chief difficulty in this direction was that of securing a staff of sufficiently high standard. And it must be said that the standard of admission to the hospital staff has been kept high from the very beginning. However, due to the post graduate courses and increased practical experience the standard of England's optometrists is being rapidly raised so that the difficulty is gradually being eliminated. The men on the staff are leaders in their profession. They give voluntarily an evening each week without pay, their service often entailing an outlay of expense from their own pockets amounting to £1 (about $5.00) or more, and this every week. One optometrist

whom it was my pleasure to meet intimately on several occasions, Mr. A. E. Turville, travels each week a distance of about 100 miles in order to give his services to the hospital. And I understand that there are many who come from considerable distances outside London.

As the patients and students continually increased, the hospital space was found inadequate for their needs. By a very fortunate chance a shop next door, which had been an office equipment store, became vacant and the hospital was enabled to purchase this on suitable terms. By the expenditure of a considerable sum the alterations were made and I was amazed to find what a very neat, attractive and efficient hospital the new hospital building presented both from the outside and inside.

The new, enlarged hospital was only opened last February. At the opening ceremony were present the Earl and Countess of Mayo, Sir Commander Abethnaught Lane, a leading physician who started the New Health Society, and the Rt. Hon. Tom Shaw, M. P. And judging from the rapidly growing demand for services at the hospital, it seems that another opening ceremony will soon be in order. For the hospital is already found too small. Each evening long before the appointed hour for opening one sees long lines of people awaiting the opening of the doors. One is impressed with the genuine service these optometrists are giving to the community at large, for it enables thousands of people each year who would be unable to afford the fees of a high grade optometrist in his private practice, to have the services of first class men, high in the profession, practically without cost or by the payment of a very nominal fee. Another important service is that optometrists of lesser experience have the opportunity to consult with experts on any matters that may be troublesome to them, getting the benefit of expert advice on special cases demanding special attention. At the present time less than half of the patients coming very night for services can be accommodated. Thus more than half of those who come for services must be turned away. This shows at a glance how the new hospital is beginning to be inadequate for the needs of the community.

The hospital is surprisingly well equipped. In addition to the waiting room and the matron's offices on the ground floor, it has a sight testing clinic about forty feet square, with about fifteen ophthalmic cubicles, each cubicle completely equipped for examining purposes. At one part is a railed off enclosure for special instrumentation work. In the basement is a room fitted up with various apparatus for muscle training and for dealing with cases of squint. On the first floor there is a library, reading room, private office of the director, a Lecture Theatre, which seats 150. On the floor above is the Students' Common Room and Matron's quarters.

On the evening of April 19th it was my pleasure for the first time to demonstrate in this Lecture Theatre, the Photoscope, in connec-

tion with a lecture on Dynamic and Static Retinoscopy. The audience was truly enthusiastic and the instrument was commented upon by many as being a real advance in retinoscopy. Under the auspices of the Institute of Ophthalmic Opticians, it was also my honor to give the first formal lecture by an American in this new Lecture Theatre on the evening of April 25. At that time I delivered a lecture entitled, "Observations on Muscles, Amblyopia and Diplopia Exercises." The discussion which ensued, enjoyable as it was, threatened to become so lengthy that the director of the hospital, the genial Dr. A. J. Preston, humorously suggested that as the lecturer had already answered questions ranging from the philosophical dilemma of materialism and idealism down to the problems of how to have a baby it was about time to call a halt. This lively discussion certainly showed the intense interest that the British optometrists have in new ideas, new viewpoints, and how critical some of their men are in examining new ideas. Having lectured before optometric audiences throughout the United States I can pretty well gauge the mental caliber of my audience and I can truly say that my lecture at the Refraction Hospital was one of those that I keenly enjoyed because of the intelligent, critical attention of my audience.

It may be said in connection with this that during the week of my lecture there were two other lectures given previous to mine. One was the annual Ettles lecture which is held each year in honor of the memory of the man who had been such a kind friend to refractionists, Dr. Ettles. The second was the first meeting of the Research Committee of the Institute of Ophthalmic Opticians. Having been present at the two previous lectures of that week as a listener and participant in the discussions I was agreeably surprised to see a third large audience at my lecture. To draw three audiences in the same week is a feat that certainly speaks well for the desire for increased knowledge on the part of our British optometrists.

Incidentally the research committee whose work is fostered by the Institute of Ophthalmic Opticians is doing some very fine work and I was certainly pleased to have been the first American present at the presentation of their original papers and to have participated in their discussions. They are broad minded men and take criticisms in the manner of scientists and though I differed in my opinions in some respects from the viewpoint presented by the research workers, the announced comment before the audience by the director of the hospital was that they wished they had me with them to assist in their researches. This research work is a very important phase of the work of the Institute of Ophthalmic Opticians, and has recently been very much emphasized.

At present there are nearly 1,000 students on the books of the Refraction Hospital. Since optical qualification is at present optional in England, all the men who attend are mostly practicing opticians

who are anxious to improve their knowledge of optometry. They do so entirely voluntarily. The hospital is open for practice to students who possess the sight-testing diploma of the Worshipful Company of Spectacle Makers, of the British Optical Association, or of the Optometric Boards of those colonies and countries which legally recognize optometry. It is also open to students registered for any of these examinations who give satisfactory proof of their knowledge of the optical principles of sight-testing and of their skill in practical methods of refraction. The hospital further admits as students in special instances those recommended by the Council of the Institute for admission. However, students who have not previously had any of the required diplomas must first pass an examination for entrance, and even such diplomats must give proof of their proficiency.

An idea of the depth of study covered by the courses given in the hospital can be gained from the following headings, each one covering about twelve to fifteen topics: General Physiology, General Pathology, Embryology, Anatomy and Histology, Ocular Physiology, The Fundus, Motor Apparatus of the Eye, The Drugs Used in Refraction. The hospital course lasts about twelve months and consists of between twenty-five to thirty lectures dealing with subjects, as one can see from the above list, from elementary chemistry to most advanced matters the refractionist is likely to deal with. The lectures, which are given twice weekly, are supplemented by attendance in the main theatre of the hospital.

It is in the clinical facilities of the hospital, the actual observation of cases, that the hospital is really a unique institution in the world. It provides clinical training in all phases of refraction, muscle work and ocular pathology that is superior to any that I have seen at any institution run by optometrists anywhere. The staff at present numbers about fifty and these men as a rule are certainly men of caliber. The keen understanding of the problems of refraction and muscle work which some of these men displayed in conversation was very pleasing indeed though it cannot be said that all are on the same high level. The hospital is certainly fortunate in having as its director, Dr. A. J. Preston, a man of extraordinary personality. He is well versed in everything pertaining to refraction and ocular pathology, being a D. Sc. besides a pharmacist and optometrist, and he combines with his extensive knowledge of the work of refraction in all its phases a most pleasing personality and the gift of putting knowledge across to the student that only a man who has himself taught can appreciate. And with it all he bubbles over with good spirits, good humor and the milk of human kindness. He is indeed an ideal teacher and the comments of the students show that they realize it.

Use of Drugs

Probably not many of our American optometrists know that

English optometrists are not forbidden the use of mydriatics and cycloplegics. A good many refractionists use these, some in routine work and some on special cases. There are to be sure a great many who look adversely on the use of drugs by refractionists and the advisability of the inclusion of drugs in the work of the optometrist is a hotly debated question now among British optometrists. But the fact is that they are not prohibited from using it and take advantage of this fact. And because of the oft repeated assertion by American ophthalmologists, in trying to belittle the work of optometrists, that the optometrist cannot use drugs in refraction, British optometrists are apprehensive that registration with the prohibition of the use of drugs may do them more damage than their present state of non-registration with the privilege of using drugs. At the Refraction Hospital a regular course in what they call Optometric Pharmacy is given and the students are taught the use, dosage and application of these drugs. Recently a new mydriatic and cycloplegic was recently worked out by some optometrists and placed on the market for use by British optometrists.

Optical Organizations in England

There are a number of large optometric organizations in England. Exclusive of many local ones these large organizations which aim to be national in scope are primarily three. They are the Worshipful Company of Spectacle Makers, The British Optical Association, and the Institute of Ophthalmic Opticians. But in addition to these three main ones there are a number of smaller ones, which although they do not have the recognition which these three have, do have a membership that is not negligible by any means. Of course to many the division in the ranks of the British optical organizations seems the greatest drawback to their advancement. And a number of foremost men to whom I have spoken agreed on that point. They said in answer to a suggestion that they had already tried various ways of getting the organizations whose standards are below the accepted ones to get into line, but somehow had been without success.

The Worshipful Company of Spectacle Makers was founded in 1629 under a royal charter given by Charles the first. This company, which is one of the few remaining medieval guilds, exercised its powers of supervision over optical goods and opticians for a great many years, but somehow its activity gradually lapsed and by the end of the 19th century was practically nothing more than a name as far as its interest in opticians was concerned. According to what seems reliable information, it was due to the inactivity of the older chartered Spectacle Makers Co. that a new association was formed and the British Optical Association was founded in 1895. The British Optical Association soon thereafter, in 1897, commenced giving examinations for opticians, setting up standards and seeking to raise the educational and public status of the optometrists in England. The Spectacle Makers Company immediately followed this

and instituted an examination in 1898, but their examination although it was intended for sight testing opticians really included very little regarding sight testing. This was found to be such an anomaly that some two years later a separate examination was instituted by the Spectacle Makers' Co., specifically for sight testing. Two diplomas were thus issued, one for the ordinary examination and one for the sight testing examination.

From September 10th to 14th, 1929, the 300 anniversary of the founding of the Worshipful Company of Spectacle Makers was being commemorated in London by a great Optical Congress and Trade Exhibition. It was an affair that was participated in by the leading optical organizations in England and at which an extensive educational program was presented. It was my regret that due to the fact that I left for the United States sooner than was expected it was impossible for me to participate in this notable event, as I had received a special invitation from the organizer of the Congress to read a paper at this Congress.

It seems that the relations between the two chief examining bodies for a number of years were not too friendly, although the diploma holders of one body readily fraternized with the diploma holders of the other. The diplomats of the Spectacle Makers Co. were in an unfavorable position as compared to the diplomats of the British Optical Association in many ways though they had the standing of the older chartered organization. The reason was that the British Optical Association took continuous interest in its members and was really an organization to which its diplomats could turn for advice or protection in any of the difficulties which arose. Whereas the Spectacle Makers Co., though it had the higher standing of royal charter, merely held examinations and awarded certificates, but after that the members were left to look out for themselves. The diplomats of the Spectacle Makers Co. in fact felt this to be such an anomalous position that a number of them got together and discussed with Mr. Lionel Laurance, the official instructor of the Worshipful Company of Spectacle Makers, the question of the foundation of an institute, which should act as a link between the various members of the Spectacle Makers Co. and to which they could turn for advice and help when needed.

Such an institute was officially founded in July, 1905, as the Institute of Ophthalmic Opticians. The surviving founders of the Institute are: Mr. Lionel Laurance, Mr. F. W. Bateman, Mr. A W. Boatman, Mr. G. C. Bateman, Mr. J. C. Kidd, Mr. E. K. Spiegelhalter, Mr. H. W. Freeman, Mr. J. H. Cuff, Mr. H. M. Selfe. In 1911 it was decided that the Institute should extend its membership so as to include diploma holders of the British Optical Association. In 1912 this became an established fact. The first member to join the Institute under the new regulation was Mr. Owen Aves, the well known leader of the British optometrists who recently passed away.

In 1925 it was decided to extend the membership of the Institution still further so as to admit any experienced optician of reputable standing who complied with certain conditions laid down by the committee so that now the Institute really includes all classes of reputable opticians. It has been instrumental in founding the Refraction Hospital and in founding the J. C. Q. O. (Joint Council Qualified Opticians). This council handles over £300,000 per annum of the work of insured persons during the year. In the last campaign the Institute of Ophthalmic Opticians was practically supporting two candidates for the House of Commons in the interests of the optometric profession. It has done all in its power with the Joint Council Qualified Opticians (J. C. Q. O.) for the bill that was presented in the parliament in 1927. The Institute now has a membership of well over 2,000, quite a proportion of whom are overseas. It is no exaggeration to say that the Institute by means of its local associations and its personnel work has done more to unite the optometrists of England than any other single organization.

The Institute is also engaged in optical research work and is at the present time spending at the rate of about £600 per year (about $3,000) on research work. This is quite a new venture and will unquestionably lead to valuable results. The first report of the research workers at which it was my good fortune to be present, showed the zeal with which the research workers entered into their work and this indeed promises to be one of the major accomplishments of the Institute. The research workers are associated with the Northampton Polytechnic Institute of London. This is an affiliated institution of the University of London and has for many years provided one of the foremost educational establishments in the country for the practical training of optometrists and everything pertaining to lenses, frames and sight testing.

The secretary of the Institute as well as of the hospital is Mr. F. T. Gregg, M. A. Mr. Gregg is an efficient and gracious gentleman who has held these positions for a great many years and is very highly esteemed by all British optometrists.

The British Optical Association, founded in 1895 and incorporated in 1899, has grown in importance and membership so as to be now probably the largest examining body in England. It conducts several examinations such as preliminary examinations, the fellowship examinations, and the honors examinations, and then the supplementary examination for recognition of pathological conditions. It has its own library, its anatomical and pathological museum, publishes its own bulletin and is very active in fathering the profession in every way. Mr. J. H. Sutcliffe, secretary since the foundation, is one of the two English optometrists best known in the United States, the other one naturally being Mr. Lionel Laurance, who is so well known in the States through his books and his lectures at the A. O. A. convention.

The Joint Council of Qualified Opticians

This is a very important body that was born in January, 1923. It is a clearing house for the various approved societies which were giving to the members what is known as ophthalmic benefit under the National Health Insurance Act. Upon the registrar of the Joint Council of Qualified Opticians at present are placed only those opticians who hold the diploma of the Spectacle Makers Co. or the British Optical Association. The restriction of membership only to those holding diplomas from the above named bodies has caused a certain amount of hard feeling and resentment amongst many holding diplomas from other examining bodies. But at the time the Joint Council of Qualified Opticians was formed there were no other bodies in England holding examinations of reputable standing. The men at the head of the Joint Council of Qualified Opticians felt that it was imperative that such optometrists as undertook the responsible duty of supplying glasses under a government measure should be only those men who had proved their knowledge in a way that was capable of being cited before the public in any case of dispute.

Other examining bodies have since started, but the Joint Council of Qualified Opticians has made no alteration in its membership. In this it appears to be justified since at a government inquiry held upon the optical practitioners' bill in 1927, although all the examining bodies gave evidence, the only three examining bodies of which approval was expressed were the Spectacle Makers Co., British Optical Association and the Institute of Ophthalmic Opticians. The Joint Council of Qualified Opticians has at present over 4,000 members, roughly one-half holding diplomas from the Spectacle Makers Co. and one-half from the British Optical Association, a number of men holding both diplomas.

Lesser Organizations

Of the other organizations the following may be mentioned:

Institute of Chemist Opticians, this was founded some five or six years ago with the view of banding together all those qualified pharmaceutical chemists who practiced optometry. It is interesting to observe that in England optometry is very frequently combined with pharmacy, probably in as frequent proportion as optometry has been combined with jewelry in the United States. This body holds an examination, the standard of which is however regarded as below those of the other examining bodies. It is an organization which carries little weight and a very large number of chemists refuse to be associated with it, as some claim the Institute does not uphold the dignity of the optometric profession.

Another institute is the College of Optics. This is a very large Scottish institution which was founded in Glasgow some few years ago. It was founded as an educational institution in which students

in optometry were taught and examined and then given a certificate by the principal of the school. The method of conducting teaching and examinations and the granting of certificates was not found altogether satisfactory and changes in the institution have been brought about. Now the whole organization has been handed over to a properly constituted body separate from the teaching department. This body holds examinations and gives diplomas, but its standing up to the present is not very high.

Another organization is the National Association of Opticians, which is an offspring of another organization, which began about the year 1909-10 and existed in the north of England. This was an organization for getting opticians together, arranging lectures and reading papers with a view to mutual educational assistance. This organization grew to become an active and rather large society. However, after some time the scope of the organization was enlarged and after considerable discussion and opposition it decided to issue certificates to members. This created serious division in the ranks and a considerable number of the members resigned. Those who remained altered the name of the society to National Association of Opticians and formed an active organization on the lines of the Institute of Ophthalmic Opticians. Its standard of membership was rather low and merely the fact of having been a reputable optician in practice for not less than three years was sufficient for admission. This body existed and did useful work in its own particular sphere along this line until the year 1923. But in 1923 as a result of differences with one of the examining bodies a separate examination was organized and held by the National Association of Opticians. There is this fact to their credit that they were the first institution in England to institute as part of the syllabus an examination in pathological and abnormal conditions of the eye. Of course the Spectacle Makers Co. and the British Optical Association have included that since. Examinations of the National Association of Opticians are still held regularly and according to the opinion of some capable observers its standard is said to be of a satisfactory character. The National Association of Opticians has roughly about 1,000 members, the membership including many who are members of the other optical bodies.

Special Organizations

The National Council for the Preservation of Eyesight is an organization founded in 1925 and composed of representatives of four bodies. These are the Wholesale Association of Opticians, the British Optical Association, Institute of Ophthalmic Opticians and the Joint Council of Qualified Opticians. It was formed largely for the purpose of co-operative advertising so as to educate the people to the advantages and the need of glasses. Funds are provided by means of a voluntary levy of 2½% on the wholesaler's account with the opticians who are members of the National Council for the Preserva-

tion of Eyesight. To this amount the wholesalers add ½% and this provides approximately some £10,000 a year (about $50,000) which is expended in various provincial and local papers up and down the country. This organization has undoubtedly been of considerable service to the community and it has certainly been the means of increasing the eye consciousness of a very conservative people. When one realizes how in the activities of this one organization alone the "phlegmatic British" are far and away ahead of the American "enterprising optometrists"—one is given to recast values.

Optical Schools in England

There are a number of splendid optical schools in England, public and private. The Northampton Polytechnic Institute affiliated with the University of London gives a two year course preparing candidates for the various examining bodies.

The School of Optics, Ltd., headed by Mr. Lionel Laurance and his associate, Mr. H. Oscar Woods, is one of the oldest schools and prepares students mainly for the examination of the Spectacle Makers Co., of which Mr. Laurance has been the official instructor for over thirty years. Our American optometrists know Mr. Laurance better than any other English optometrist through his writings. The School of Optics, Ltd., has extensive day and night courses and prepares students for all the other examinations in addition to the examinations of the Spectacle Makers Co.

Another school is the British Optical Institute headed by Dr. Max Coque. This school also prepares students for all the examinations, though most of its students take the British Optical examination. Mr. Laurance and Dr. Coque are regarded by the British Optical Association as two of their chief educational workers, who have been doing valient service for optometrists for upwards of thirty years. And their splendid work is often commented upon in talking to optical leaders. There are very few of the leading optometrists today who have not passed through one or the other of the educational institutions conducted by these two men. Besides the schools there are a number of private tutors who prepare students for the examining bodies. The policy of the examining bodies is broad inasmuch as they will admit anyone irrespective of where he was trained.

In talking about schools one must not leave out the Refraction Hospital, which gives advanced courses in all phases of refraction, muscle work and pathology, the extent of which can readily be judged by reading over the Prospectus of the hospital. Only those students who already have some qualifications from the other examining bodies or are especially recommended by the council of the Institute are considered for admission. The hospital therefore acts as a sort of supplementary post graduate course to the other schools.

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OCULAR ELECTROTHERAPY

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CHAPTER XII.

HIGH FREQUENCY TECHNIQUE

The Use of Different Electrodes and Their Effects

There are different types of electrodes used in the application of therapeutic currents. Those used mostly are:

1. Vacuum electrodes.
2. Non-vacuum electrodes.
3. Block tin and lead foil.

The vacuum type of electrode is made up of a thin glass tube from which the air has been exhausted. When the current passes through the electrode, a constant glow is to be noticed in the tube. This glow varies in color from white-blue, medium blue, red or red-pink. It is claimed that electrodes giving off certain color glow are more effective in special cases. For instance, it is claimed by some that an electrode giving off a red or red-pink glow is most effective when applied to acute conditions while a blue and blue-white is more effective in chronic conditions. However, these claims are only theoretical and are not born out by clinical experience. The vacuum electrodes are made up in different shapes so as to fit the various places they are applied to. What we are here interested in mostly, are those suitable to be applied to the eye. There are three electrodes suitable for this purpose: The single eye electrode, the double eye electrode, and the general surface electrode, as shown in figures 15, 16 and 17 respectively.

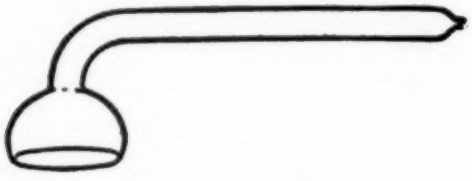

Fig. 15—Single Eye Electrode.

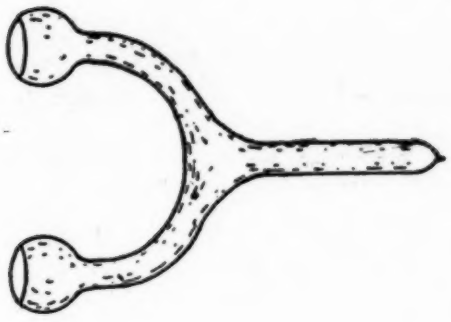

Fig. 16—Double Eye Electrode.

Fig. 17—Body Surface Electrode.

The surface electrode, as well as the single and double eye electrodes, are made up in vacuum and non-vacuum types. The double eye electrode alone can practically be applied in all eye cases, and where only one eye is to be treated one lobe is placed over the eye to be treated and the other may extend out to one side of the head.

Describing the effects of the vacuum tube application, Eberhart claims that they are as follows:

1. Increased blood supply to a given area,
2. Increased oxidization and local nutrition,
3. Increased oxygenation of blood,
4. Increased intake of oxygen,
5. Increased output of carbon dioxide,
6. Increased secretions,
7. Increased elimination of waste products,
8. Liberated ozone, with the resultant benefit of more or less of this ozone being inhaled by the patient and also probably carried directly into the tissues,
9. Increased bodily heat, without a corresponding rise in temperature,

10. Locally germicidal,
11. Mild and medium sparks stimulate or soothe according to length and character of application,
12. Strong sparks are caustic,
13. Sparks to spine increase arterial tension,
14. Promote absorption of plastic exudates or adhesions.

These effects of vacuum tube applications while essentially local, are not absolutely so. The current traverses the body in all directions from the point of entry, but is, of course, most intense and pronounced at the latter point. Prolonged applications of vacuum tubes will give systemic effects, but these are obtained more easily by auto-condensation.

A non-vacuum electrode is one that is metal lined instead of having an air vacuum, and the connection from the current supply is made directly to the metal instead of indirectly to a rarefied air layer. The non-vacuum type of electrode has many times the capacity of the vacuum electrode of similar size, because a metal of metal-coated surface will hold many times the quantity of charge that an ordinary vacuum electrode will hold.

Sampson cautions that when a non-vacuum electrode is used care should be taken to use only the regular genuine type and not the substitutes, which are much inferior and will not hold the same amount of charge, he also claims that glass walls of the inferior type are too thin and are liable to explode, due to the electric stress of the current, and may burn the patient.

The block tin electrode is a metallic compound which is procurable in various thicknesses (or gauge). This is pliable and can be easily molded to the contour of any area to be treated. There is also the mesh electrode which is made up of very small links of specially alloyed metal. This makes a very desirable eye electrode due to the fact that it is very flexible and conforms most accurately to the contour under treatment. The block tin and mesh electrodes are indestructible and are very easily sterilized. They can be procured in any size as can be seen from figures 18 and 19.

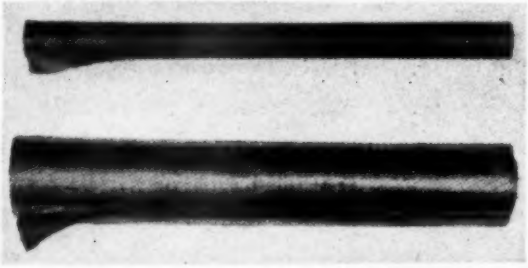

Fig. 18—Block Tin Electrode Material.

Fig. 19. Mesh Electrode.

The block tin can be cut with scissors to any shape or pattern desired. In preparing this type of an electrode, care should be taken that the edges are made smooth and slightly rounded, also that the corners be rounded off. This will not only make the application of this kind of electrode more comfortable, but will also prevent sparking and the concentration of the current in one place which may cause burns. For this last mentioned reason, it is also important to see to it that the tin electrode makes perfect contact over the entire surface to be treated, this may be accomplished by the application of a roller gauze bandage.

Technique

There are two types of techniques used in the application of High Frequency Currents, namely:

1. The Sedative Technique,
2. The Stimulative Technique.

The High Frequency Sedative Technique is applied when a mild current is passed through the tube and when the tube is in contact with the part under treatment. The Stimulative Technique is applied when a strong current is passed through the tube and when the tube is removed from the surface to be treated, thus allowing a spark to pass. When the current passing through the tube is made still stronger and the spark still further increased, it is then no longer stimulative, it becomes caustic and destructive. Care must be taken when the vacuum electrode is applied, especially when the stimulating technique is used, not to cause any burns. Special care is to be taken when it is applied to a surface which has a fine, fuzzy growth of hair as they may set afire when the spark is very strong. The stimulative technique should never be used in places where strong alcoholics are used.

In applying the sedative technique, the electrode is to be applied gently and the high frequency current is to be turned on slowly up to tolerance, and then lowered somewhat because if the current is left at tolerance, the surface under treatment will become uncomfortable and the electrode will soon have to be moved and those cause

still greater discomfort from the spark, which is then of a caustic nature. When the current is turned down a little from the tolerance point, it is possible to hold the electrode on one place for a while until that place gets warm, then slide the electrode its full width along the surface which is to be treated. This operation is to be repeated until the entire area is covered and then turn to the starting point and repeat the operation.

In applying either the sedative or stimulative technique in high frequency, it is important that the dosage (measuring the amount of current) be given consideration. There is the hot wire meter to measure diathermy currents, but there is no meter to measure H. F. of the uniterminal currents passing through the vacuum or non-vacuum tubes. In this case, the length of the spark that can be drawn from the tube is a fair indication as to the amount of current passing through it. The stronger the current the longer the spark. When the current is reduced the spark becomes shorter.

With a little practice, one will have no difficulty in adjusting the instrument so as to get the proper size of spark the patient will be able to tolerate with comfort. Sparks varying from one-eighth to one-half inch are mostly used. The length of the spark to be used will vary with the type of a machine used and with tolerance point of the patient to be treated.

The resistance of the tissues is to be taken into consideration when therapeutic current is to be applied. The different tissues of the human body offer varying degrees of electrical resistance. This is of special importance in the application of diathermy in view of the fact that the amount of heat produced by the application of diathermy depends largely upon the resistance of the different tissues. Grover[48] gives the tissue resistance in percentage form, in the following table which is of interest:

RELATIVE RESISTANCE OF BODY TISSUES

Bone	100
Fat	90
Skin cold and dry	80
Skin warm and moist	50
Brain	50
Scar Tissue	40
Liver Sclerosed	40
Normal Lung	30
Intestines	30
Glands	25
Muscles	20
Liver	10
Recent inflammatory exudates	5
Blood	1

The resistance of the tissues to the current is much less when they are warmed up. This can be noted particularly when diathermy is applied, for after the current has been applied for a few minutes it will be noted that the milliamperage reading on the meter will be higher than when the treatment was first started, indicating that the tissue resistance has been lowered.

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[48]B. B. Grover, High Frequency, p. 99.

JAVAL'S RULE FOR COMPUTING ASTIGMATIC CORRECTIONS, FALSE*

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There is a marked tendency, for professional men to accept the statements of recognized authorities without investigating, which falls but little short of hero worship. All are guilty to some degree. This continues though all know that some of our outstanding men, past and present, have sponsored theories now known to be false. There can be no question as to the merit of the work done by Javal. It is unfortunate that his rule for computing the astigmatic correction from ophthalmometer findings falls in the class of what I believe to be false.

Javal's rule, briefly stated is, "Add 25% of the astigmatism with the rule and deduct a half diopter." The accepted explanation of this is that the correcting lens acts in a plane, not at the cornea, but ahead of it and hence has a lesser effectivity in the corneal plane. This accounts for the 25% addition. The half diopter is deducted because the optic axis and line of fixation do not coincide. The line of fixation usually passes slightly to the nasal side of the pole of the cornea.

Let us consider the first half of the rule. It is, I believe, incorrect because the decrease in effectivity of the lens is not a constant, but differs for each power. For instance a — .25 cylinder placed 15 mm. from the cornea has the effect in the corneal plane of a — .2409 cylinder. This is a long ways from 25% decrease. Let us take a — 2.00 cylinder. Placed 15 mm. ahead of the cornea it has the effect of a — 1.941 in the corneal plane. This is nearer but it still falls considerable short of a 25% decrease in effect. As the astigmatism grows higher the 25% becomes more nearly correct until at about 16.66 of astigmatism it is correct. Please note that this is for minus cylinders. If plus cylinders are used the effectivity is increased and not decreased. This means that the per cent is to be deducted and not added.

Now for the second half of the rule. The half diopter is calculated on the assumption that the angle between the optic axis and the line of fixation is five degrees and that the cornea has a radius of 7.5 mm. We have no means of measuring the angle in our offices, and so it is impossible to state how much this is in error. It suffices that it is known that in a great many cases it is not five degrees. Our ophthalmometer tells us that there is a wide variation in corneal radii.

From this we may conclude that the latter part of the rule is only approximately correct and that the former part is grossly incorrect.

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THE PHOTOSCOPE

The Photoscope recently introduced by Dr. J. I. Pascal endeavors to solve the fixation problem in static skiametry. Essentially the instrument consists of a tube containing a small source of light, placed above a blue-violet filter and a perforated diaphragm. The blue-violet beam of light passing through the aperture is converged by a condensing lens placed near the bottom of the tube. This slightly convergent beam of light falls on a plane mirror placed directly underneath and at an angle of 45 degrees and is reflected into the patient's eyes.

The Photoscope is designed primarily to provide a fixation spot in front of, rather than behind, the examiner, who can move backwards and forwards in all directions without interfering with the patient's view of the spot light. He therefore has absolute freedom of movement and is never in that more or less cramped position which is sometimes experienced when the fixation spot is behind the examiner.

According to Pascal*, ciliary relaxation is provided by the application of several optical principles, the most important of which is the employment of the well-known principle of chromatic aberration, the extent of which has been measured by several observers. Their figures run somewhere between aberration of a dioptric value of 1.3 diopters to about 2.7 diopters. That means that it will take

*E. M. A. The Refractionist. Aug. 16th, 1929.

anywhere from about a 1.25 D. lens to a 2.75 D. lens to bring the least refractive red rays to the same focus as the most refractive violet rays. Taking 1.50 diopter as a low average figure for the chromatic aberration, this means that when the eye is in focus for violet it is about 1.50 diopter hyperopic for red, and when it is in focus for red it is about 1.50 diopter myopic for violet. Now, when the eye focuses an ordinary white target it has been seen that it adjusts itself for the most luminous part of the spectrum, which is the yellow, and when the eye is in focus for yellow it is about 1 diopter myopic for violet and about ½ diopter hyperopic for red. Being about 1 diopter myopic for violet the eye is then in focus for a violet object at a distance of about 1 meter (40 inches), so that when a blue-violet light is placed at 1 meter from the eye and the eye is exactly focused on it, it will be in exactly the same state of accommodation as when it looks at a white object at 20 feet and is then in focus for the yellow. The Photoscope makes use of this principle by providing a blue-violet target, which at a closer distance will give the same accommodative relaxation effect as an ordinary white object at 20 feet.

Another principle made use of is that according to the well-known laws of reflection the patient projects the spot light backwards according to the distance of the source of light. Thus the patient gets both the sense and effect of distance which are important factors in causing relaxation of the accommodation.

By placing the fixation spot in front of the examiner the instrument provides these relaxing stimuli, so that the eye, during this examination by static skiametry can be really in a static condition. Another important detail in the instrument is that the mirror used is very small, and the examiner working in the immediate vicinity of the edge of the mirror can refract the eye very close to the fovea and with practically no obliquity to the visual axis. The examination is made along what is known in optics as a par-axial direction, that is, a direction so close to the axis as to be optically considered co-incident with it. The advantage of making the examination so direct and so near to the visual axis are readily seen when one considers the inaccuracies resulting from neutralizing even an ordinary lens by looking obliquely through it. The fact that the examination can be made so near to the visual axis is one of the great advantages of the Photoscope.

While the instrument would most likely be used with the examiner working behind the small fixation mirror, thereby making a par-axial examination, it is also possible to make an examination at the center of the fovea in this way; the small mirror is set opposite one eye for fixation. The other eye is left open, thereby disassociating the two eyes, and convergence tends to relax in the eye under ex-

amination. Since accommodation as well as convergence are binocular functions, the relaxation of convergence and the relaxation of accommodation by the fixing eye causes similar relaxation of the other eye. The examiner can then examine the other eye directly along the axis, or anywhere near the axis as he chooses. It is claimed by Pascal that the instrument enables the examiner to make a direct foveal static skiametric examination without the use of a cycloplegic.

When so used the instrument lessens the discomfort to the patient, for when the mind is on the blue-violet target the intense retinoscopy light is not as disturbing to him as when his mind is on the center of the retinoscope. Furthermore, the eye is always steadied during the movements of the examiner, and never has to be redirected to the target.

The Photoscope can be used with the complete stand arrangement, or if more convenient on a wall bracket, or attached to a chair. It can be operated with the examiner working at any distance he chooses and for cases of poor vision on the part of the examiner or patient the examination can be made, claims Pascal, at very close range.

C. C. K.

ABSTRACTS

MEASURING THE INTER-PUPILLARY DISTANCE. E. Bind. The Canadian Optometrist. Vol. X, No. 11, p. 330. 1928.

Bind suggests the following technique for taking the patient's inter-pupillary distance that proves correct on comparison with the best mechanical devices: For distance, P. D. have a patient look with his right eye directly into your left eye with rule resting lightly on patient's nose and commencement of calibration in line with outer edge of pupil; then request patient to look into your right eye, and notice where nasal edge of patient's left pupil coincides with rule. To take P. D. for near, have patient look intently at the center of your forehead, and measure in same way as for distance, taking reading of his right eye with your left, and of his left with your right. Should there be a deviation of either eye, if patient can fix with the deviating eye, tilt rule slightly so that eye not being measured is occluded by the rule, allowing the turning eye to fix.

T. O. B.

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